(12) UK Patent Application (19) GB (11) 2 033 007 A

(21) Application No 7933954
(22) Date of filing
1 Oct 1979
(30) Priority data
(31) 53/126094
(32) 16 Oct 1978
(33) Japan (JP)
(43) Application published
14 May 1980
(51) INT CL³ F02C 6/12
F02B 37/14
F04D 27/00
(52) Domestic classification
F1B 2N14A 2N16A 2N1
F1C 2J1A 2J2C1
F1G 5E2
F1T B2V19A2
(56) Documents cited
GB 1104905
GB 964733
(58) Field of search
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F1C
F1G
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(54) Exhaust turbine driven compressor for IC engines

(57) A housing 20 of an actuator A1 for a waste gate valve device is integral with a housing 21 of an air compressor to enable more compact construction and to avoid overheating of a diaphragm 23 in the actuator A1. When the air pressure in a section 22 of the compressor reaches a certain level, the diaphragm 23 opens the waste gate valve, which is similar to the prior art valve (6) in Fig. 2 (not shown).

FIG.3B

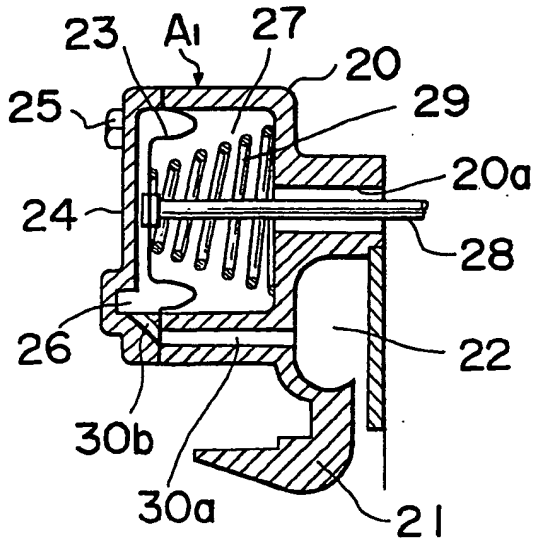

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FIG.1
(PRIOR ART)

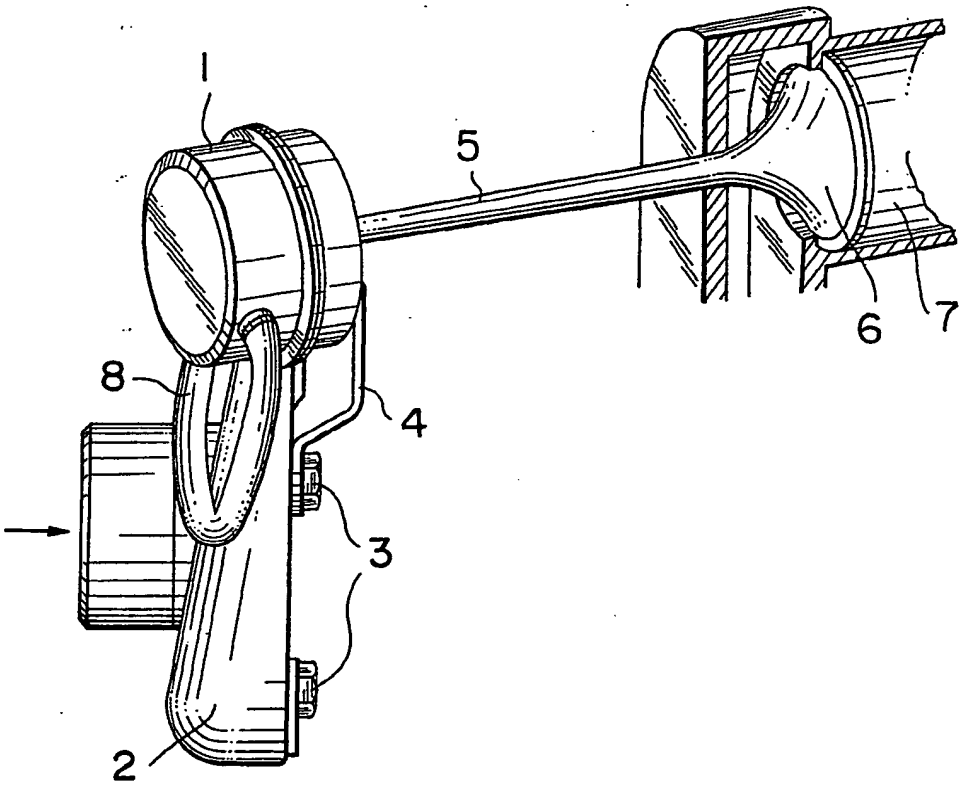

FIG.2
(PRIOR ART)

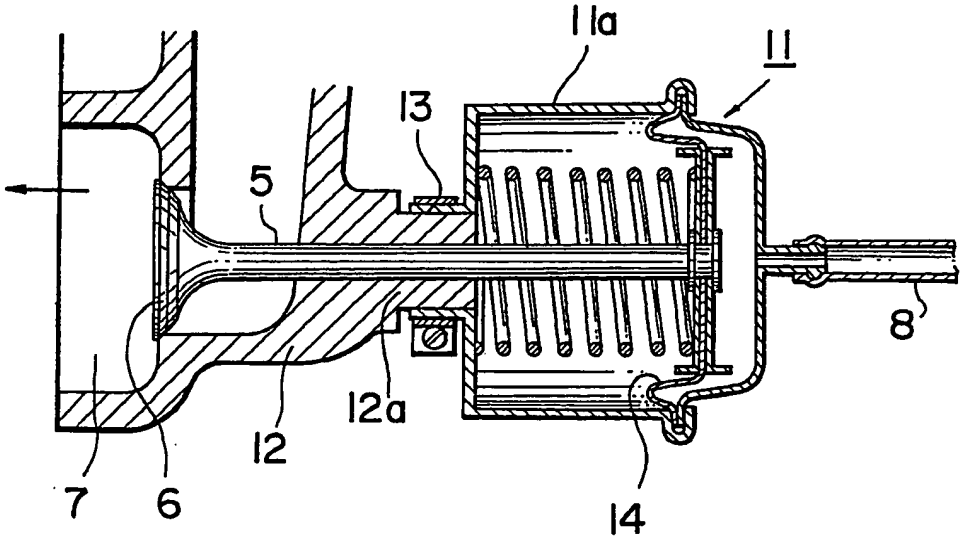

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FIG. 3A

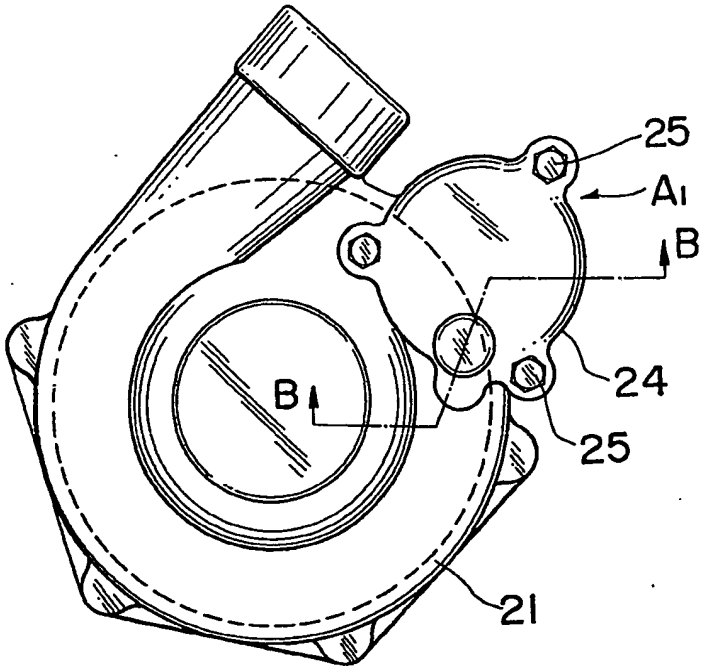

FIG. 3B

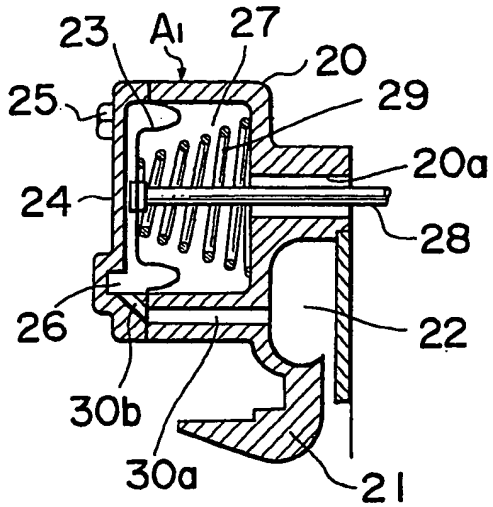

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FIG. 4A

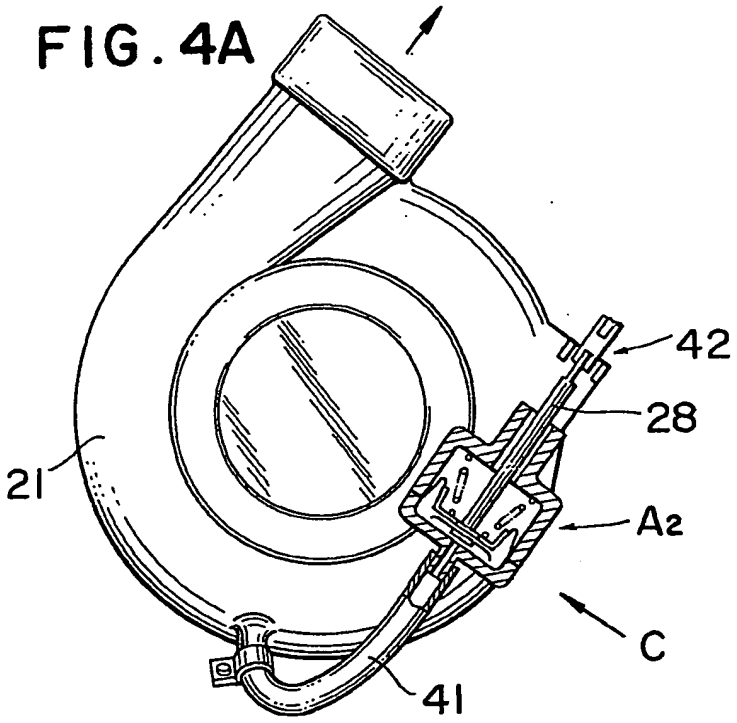

FIG. 4B

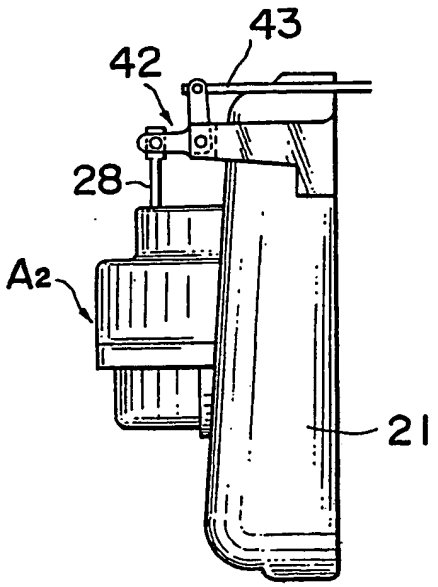

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FIG.5

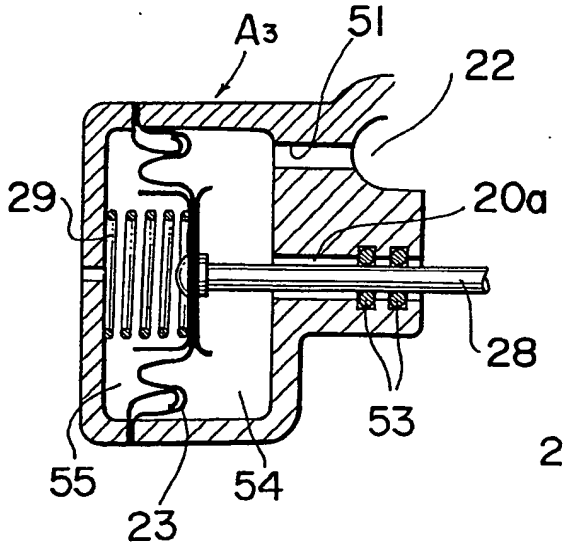


FIG.6

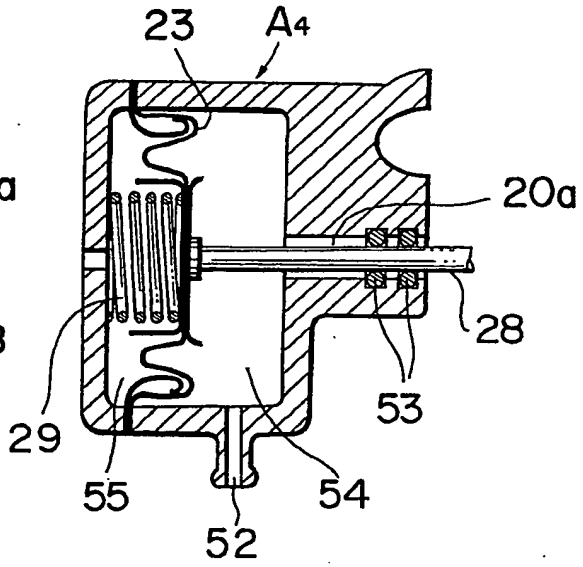


FIG.7

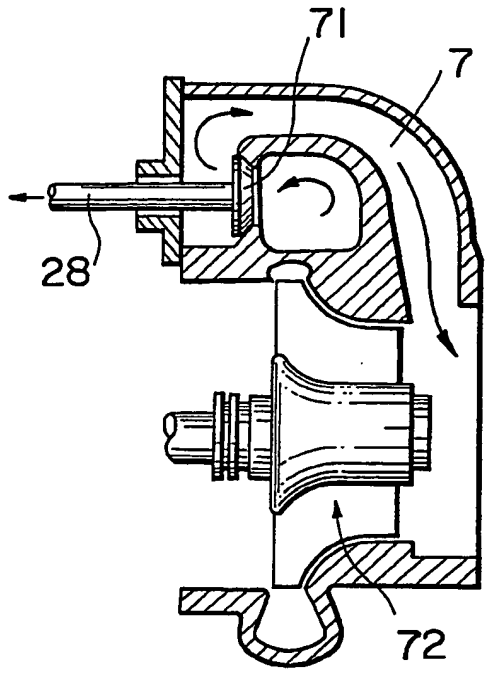
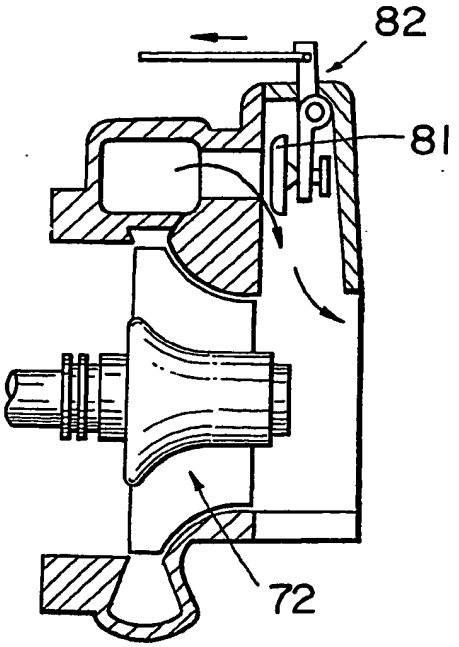


FIG.8



SPECIFICATION

Exhaust gas turbosupercharger

DESCRIPTION

This invention relates generally to apparatus for controlling an amount of supercharged air fed to an internal combustion engine, and, more particularly, to such an apparatus of the type which has an exhaust gas turbosupercharger, waste gate valve means for opening an exhaust gas passage which bypasses the exhaust gas turbine, and an actuator means for actuating the waste gate valve to open the exhaust gas passage when the pressure of the supercharged air fed to the engine exceeds a predetermined value.

An exhaust gas turbosupercharger for an internal combustion engine is a well known device in which the pressure of the exhaust gas from the engine drives in rotation an exhaust gas turbine. This gas turbine mechanically drives in rotation the impeller of an air compressor which feeds compressed air to the intake port of the engine thereby increasing the efficiency of intake and charge of air into the engine and therefore the output of the engine.

However, it is not the case that the higher the supercharged air pressure the better the performance of the engine; a pressure higher than a certain limit value is undesirable, especially because, in a gasoline engine, there is a possibility that ignition will occur too early, and this possibility is increased as the pressure of the supercharged air increases. To counter this, the prior art has provided a waste gate valve in an exhaust gas bypass passage around the exhaust gas turbine, and a valve actuator which responds to a pressure of the supercharged air higher than a predetermined value by opening the waste gate valve, thereby preventing an increase in the turbine driving torque.

The actuator is generally of a type which the pressure of supercharged air introduced therein operates a diaphragm provided therein for actuation of the valve. One problem with conventional devices has been ensuring the correct mounting of the actuator. If not mounted in exactly the correct location, its operation is not satisfactory and its lifetime may be reduced.

For example, Fig. 1 of the accompanying drawings, which will later be described in more detail, shows a valve actuator 1 fixed together with a cover plate by bolts 3 through a bracket 4 to a housing 2 of the air compressor of a supercharger. A waste gate rod 5 extends from the valve actuator 1 into an exhaust gas bypass passage 7 in which it has at its end a poppet-shaped member 6 for opening and closing the bypass passage to the passage of exhaust gas. Reference numeral 8 denoted a control pressure pipe to admit the supercharged or compressed air from the air compressor. The device shown in ig. 1, however, consists of relatively many component members and requires considerable care to mount. The positioning of the actuator so that the waste gate rod 5 will perform smooth strokes is particularly difficult. Especially, insufficient rigidity of the bracket 4 is likely to hinder smooth movement of the rod. If the valve actuator is required to be dismounted and then remounted or replaced on the vehicle, it is likely to be mounted at a position shifted slightly from the original position or to have a slightly different set pressure from the original, because of standard manufacturing tolerances. Further, since the actuator must be positioned close to the passage of exhaust gas because of its function, it is likely to be subjected to the radiation of heat from the exhaust gas. The heat imparted directly to the waste gate valve is transmitted through the rod to the diaphragm which is thereby liable to softening and deterioration.

Fig. 2 shows another prior art valve actuator 11 whose housing 11a is fitted over a protrusion 12a of an exhaust gas turbine housing 12 and secured by a tightening band 13. This device is more disadvantageous than the example in Fig. 1 in that the heat of the exhaust gas (800–900°C) is transmitted through turbine housing 12, actuator housing 11a and a relatively short waste gate rod 5 to a diaphragm 14 thereby greatly impairing the function of the diaphragm.

Further, both prior art devices shown have a common defect in that the control pressure pipe 8 for introducing positive supercharger pressure is of a relatively complicated configuration.

It is therefore an object of the present invention to provide apparatus for controlling the intake and charge of air into an internal combustion engine wherein the heat imparted to the valve actuator, and especially to the diaphragm therein, is absorbed to the compressor housing at a relatively low temperature in order to protect the diaphragm from damage and deterioration.

Another object of the present invention is to provide an apparatus of the above type wherein the valve actuator does not require any positioning adjustment and is therefore easy to mount and position.

Still another object of the present invention is to provide apparatus of the above type wherein the valve actuator is of compact construction, thereby helping to provide easy mounting.

A further object of the present invention is to provide an apparatus of the above type wherein the valve actuator can perform a stable and smooth stroke movement thereby ensuring a constant accuracy of movement.

A still further object of the present invention is to provide an apparatus of the above type

wherein the valve actuator is composed of relatively few parts.

A further object of the present invention is to provide apparatus of the above type wherein the valve actuator has a control pressure pipe of simple configuration for introducing a positive pressure of supercharged air.

According to the present invention, there is provided apparatus for controlling an amount of supercharged air fed to an internal combustion engine, comprising:

(a) compressor means, including a housing, for feeding supercharged air to said engine,

(b) exhaust gas turbine means driven by the exhaust gas from said engine and mechanically driving said compressor means,

(c) a bypass passage means allowing exhaust gas to bypass said turbine means,

(d) a waste gate valve means disposed within the bypass passage and including a movable member, the movement of which controls whether or not exhaust gas is allowed to pass through the bypass passage means, and

(e) actuator means for actuating said waste gate valve member depending on the pressure of the supercharged air, actuator means including ;

(a) a housing

(b) a diaphragm member disposed within said housing and partitioning the interior of said housing into two chambers,

(c) a means whereby the first of said two chambers is maintained at a substantially constant pressure,

(d) means whereby the second of said two chambers is maintained at the pressure of the supercharged air, and

(e) a rod member connected at one end to said diaphragm member, passing through any one of said two chambers, and connected at the other end to said movable member of said waste gate valve means, in such a way that said waste gate valve means is opened to allow the passage of exhaust gas through the bypass passage when the supercharged air pressure exceeds a predetermined value,

said housing of said actuator means being cast integrally with said housing of said compressor means.

The means by which the foregoing and other objects can be attained will be readily understood by reference to the following description and to the attached drawings.

Figures 1 and 2 show perspective and sectional views respectively of prior art devices;

Figures 3A and 3B show a side view and a sectional view taken on line B–B of Fig. 3A, respectively, of an actuator means mounted on a compressor means used in apparatus according to the present invention;

Figure 4A shows a side view of a modification of the present invention wherein the actuator means is shown partially in section for the prupose of illustration, and Fig. 4B shows a side view of the modification of Fig. 4A seen in the direction of the arrow C;

Figures 5 and 6 show sectional views of the other modifications of actuators according to the present invention; and

Figures 7 and 8 show sectional views of other modifications of waste gate valves.

In Figs. 3A and 3B, a preferred embodiment of this invention is shown. An actuator A_1 for a waste gate valve (not shown) has a housing 20 integral with a wall forming a scroll section 22 which is the outlet of a compressor housing 21. This structure may be accomplished for example by casting, founding or diecasting aluminium. Actuator housing A_1 has a cover 24 secured thereto by bolts 25 with a diaphragm 23 being at its periphery held airtightly between housing 20 and cover 24. Thus, between diaphragm 23 and cover 24 is defined a pressure actuation chamber 26, and on the opposite side of diaphragm 23 is defined an atmospheric chamber 27. The atmospheric chamber 27 contains a diaphragm spring 29 which urges diaphragm 23 to the left as seen in Fig. 3B (in the direction of closing the waste gate valve). A waste gate rod 28 is at one end connected to the diaphragm 23, extends through a bore 20a formed in the actuator housing 20, and is at its other end coupled with a valve member such as shown at 6 in Fig. 2. Housing 20 and cover 24 have in the confinement of their walls control pressure passages 30a and 30b, respectively, which connect to form a communication between compressor scroll section 22 and pressure actuation chamber 26.

In operation, the supercharger compressor is driven through an exhaust gas turbine (not shown) by the exhaust gas from an internal combustion engine (not shown). As the rotational speed of the compressor increases with an increase in the rotational speed of the engine, the compressor feeds the supercharged air to the intake port of the engine at a pressure which increases according to the pressure-flow rate characteristics inherent to the compressor. The air pressure within scroll section 22 is substantially equal to the pressure of the supercharged air within the outlet passage of the compressor. The pressure within the scroll section is transmitted through control pressure passages 30a, 30b into pressure actuation chamber 26 of valve actuator A_1, and thus as it increases, it forces diaphragm 23 in the pressure actuation chamber 26 in the direction of opening the waste gate valve (to the right in Fig. 3B). When this force acting on diaphragm 23 is sufficient to overcome the set pressure of diaphragm spring 29, the waste gate valve such as 6 in Fig. 2 which was closing the bypass exhaust gas passage such as 7 in Fig. 2 will be opened to an extent depending on the magnitude of the

force to form an exhaust gas flow which bypasses the exhaust gas turbine such as that shown at 72 in Figs. 7 and 8 which will be described later in more detail. This suppresses a rise in the rotational torque of the turbine and thus a corresponding rise in the output of the compressor thereby preventing the supercharger pressure from increasing beyond a predetermined value.

In accordance with the structure of the device according to the present invention, actuator housing 20 is formed integrally with compressor housing 21. That is, the actuator is fixed at a predetermined position relative to the compressor housing. No fixing members such as bolts are required for fixing the actuator to the compressor housing as was the case with the prior art devices. This serves to make the exhaust gas turbosupercharger including the waste gate valve compact, and thus greatly improves the ease with which the supercharger is mounted on a vehicle. It further serves to simplify the mounting of the actuator greatly since no adjustment of the position of the actuator is required. Thus assembly is more efficient, no errors can occur in the setting of the actuator, and smoother operation of the actuator and increased accuracy of intake and discharge into and from the engine result.

A large amount of air flows through the compressor, and thus the compressor housing 21 is maintained stably at a relatively low temperature. Although the heat of the exhaust gas radiates against the actuator A_1 and, as a result, is transmitted through the waste gate valve and the rod to diaphragm 23, the heat thus transmitted is easily transmitted to and easily absorbed by compressor housing 21, integral with the actuator housing. In this way burning and heat deterioration of diaphragm 23 and similar problems are alleviated.

Control pressure passages 30a and 30b of valve actuator A_1 are formed in the confinement of the housing wall of the valve actuator. Accordingly, provision of separate pipes as control pressure passages is not required. There is no possibility that the pipes for the control pressure passage will be detached from the housing of the valve actuator or the compressor or that there will occur a leak of the compressed air due to defective connection of the pipes.

Various modifications of the above embodiment of the present invention will be clear to those skilled in the art. For example, as shown in Fig. 4, a control pressure passage for valve actuator A_2 can be formed by means of an external pipe 41 extending from the scroll section of the compressor. If the waste gate rod 28 does not immediately extend in the direction of the stroke of the waste gate valve, the diaphragm in the valve actuator housing may be connected through a rod 28 and a linkage mechanism 42 to a rod 43 of the waste gate valve in order to change the direction of action of the force.

Figs. 5 and 6 show other modifications wherein control pressure passages 51 and 52 are provided on the same side of diaphragm 23 as waste gate rod 28. Passages 20a of the valve housings through which waste gate rods 28 extend have therein seal members 53. In the particular modifications, reference numerals 54 and 55 denote pressure actuation chamber and atmospheric chamber, respectively, which are disposed in reversed positional relationship compared with the previous embodiment and modifications. Thus, when the supercharging pressure is excessive, the direction of the displacement of diaphragm 23, that is, the direction of stroke of waste gate valve member such as shown at 71 in Fig. 7, is reversed compared with the previous embodiment and modifications. Control pressure passage 51 in the Fig. 5 actuator A_3 is formed within the wall of housing 20, using no separate pipes as control pressure passages while control pressure passage 52 in the Fig. 6 actuator A_4 is formed by a separate external connecting pipe. In Fig. 7, reference numerals 71 and 72 denote a waste gate valve and an exhaust gas turbine, respectively.

Fig. 8 shows a waste gate valve member 81 of a type employing a rocker linkage mechanism 82, rather than the poppet valve type of the previous embodiments and modifications. The present invention may be applied to devices using any type of waste gate valve 81.

While certain advantageous embodiments and modifications have been chosen to illustrate the present invention, it will be understood by those skilled in the art that various other changes and modifications can be made therein without departing from the scope of this invention as defined in the appended claims.

CLAIMS

1. Apparatus for controlling an amount of supercharged air fed to an internal combustion engine, comprising:

(a) compressor means, including a housing, for feeding supercharged air to said engine,

(b) exhaust gas turbine means driven by the exhaust gas from said engine and mechanically driving said compressor meand,

(c) a bypass passage means allowing exhaust gas to bypass said turbine means,

(d) a waste gate valve means disposed within the bypass passage and including a movable member, the movement of which controls whether or not exhaust gas is allowed to pass through the bypass means, and

(e) actuator means for actuating said waste gate valve member depending on the pressure of the supercharged air, said actuator means including:

(a) a housing

(b) a diaphragm member disposed within said housing and partitioning the interior of said housing into two chambers,

(c) a means whereby the first of said two chambers is maintained at a substantially constant pressure,

(d) a means whereby the second of said two chambers is maintained at the pressure of the supercharged air, and

(e) a rod member connected at one end to said diaphragm member, passing through any one of said two chambers, and connected at the other end to said movable member of said waste gate valve means, in such a way that said waste gate valve means is opened to allow the passage of exhaust gas through the bypass passage when the supercharged air pressure exceeds a predetermined value,

said housing of said actuator means being cast integrally with said housing of said compressor means.

2. Apparatus according to claim 1, wherein said means whereby the second of said two chambers is maintained at the pressure of the supercharged air is a control pressure passage formed within the confinement of the walls of said housing of said actuator means and the walls of said housing of said compressor means.

3. Apparatus according to claim 1 to 2, wherein said housing of said actuator means has a cover, said cover having therein part of said control pressure passage.

4. Apparatus according to claim 1, wherein said means whereby the second of said two chambers is maintained at the pressure of the supercharged air is a pressure passage 41 external to said housing of said actuator means for receiving therethrough the supercharged air from said supercharged means.

5. Apparatus according to claim 1, further including a linkage mechanism linking said movable member of said waste gate valve means and said rod member of said actuator means.

6. Apparatus according to claim 1, 2, 4 or 5 wherein the second of said two chambers has a bore in the wall thereof, through which said rod of said actuator means passes loosely, and a sealing member is provided between said rod and the internal surface of said bore.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1980.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.